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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Electric Refrigeration and Air Conditioning

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Electric Refrigeration and Air Conditioning

MEANS for increasing comfort will always receive favorable consideration. If this can be accomplished mechanically, with reduction in our personal efforts, so much the better, hence the practical mechanization of the modern home. Mechanization, however, until recently was confined to labor saving devices. With the perfection of the vacuum cleaner, washing machine, ironer and systems for heating, it was logical for refrigeration and ventilation to receive due consideration; the former was the more popular as it eliminated the necessity for periodic handling of ice. Effective preservation of foodstuffs would, of course, appeal to all, for both health and economy are involved. From the viewpoint of health, however, the technicians of the refrigeration industry progressed a step further in studying ventilation and air conditioning, until today a companion industry to electric refrigeration has been developed which should have equal appeal to us all. In other words, air conditioning spells comfort, sanitation, and to many, the relief from that nasal congestion known as hay fever.

The relation of air conditioning to electric refrigeration is interesting in that practically the same type of refrigerating compressor is required for both systems if proper cooling of the air is to be maintained. It is, of course, practicable to cool by vacuum, also by means of steam jets. The use of steam for cooling purposes is an odd anomaly, but no more unique than the use of a gas flame for refrigeration. It is not the purpose of this article, however, to discuss methods of refrigeration and cooling, but rather to indicate the part which the petroleum industry has been called upon to play in the development of these new industries.

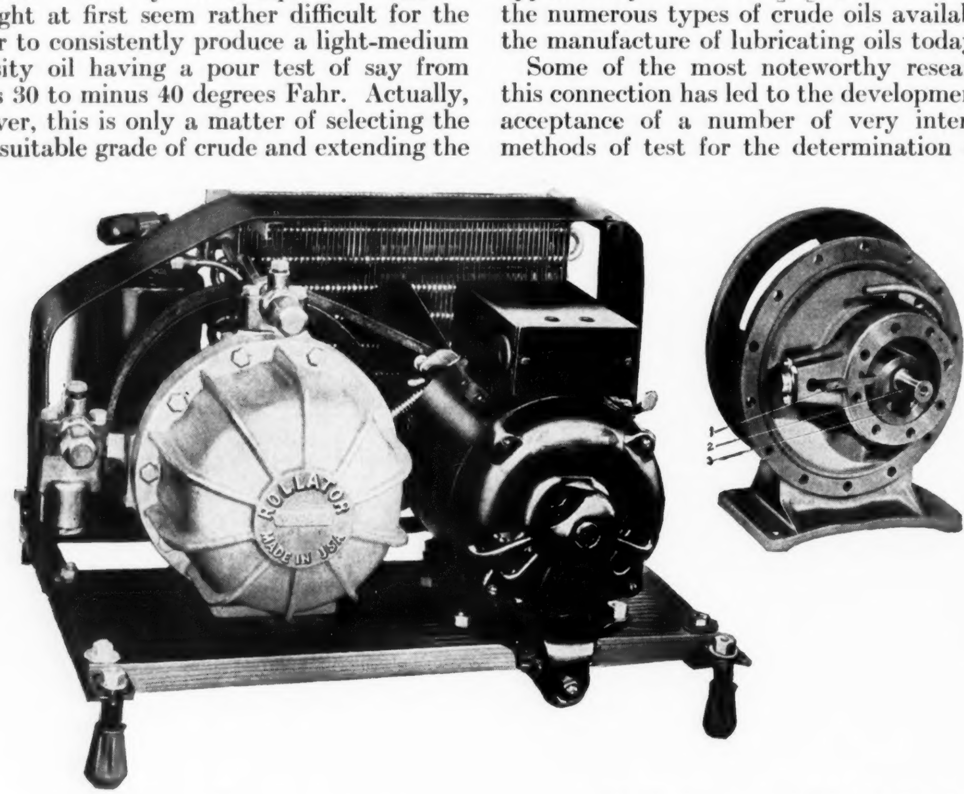
Normally the average man in the operation of his electric refrigerator or air conditioning unit is never required to think of lubrication. The parts are out of sight, and oftentimes sealed to prevent any possibility of tampering with the mechanism. In fact, the modern compressor, in contrast to the automobile engine, is built so one cannot change the oil, and yet the oil in the crankcase of the compressor is probably the most important adjunct to continued and economical operation. The refrigerant, of course, does the actual work of cooling by its continual passing through a cycle of compression, condensation, expansion and vaporization. The lubricating oil, however, keeps the mechanical parts functioning with proper respect to one another, and eliminates the possibility of abnormal wear.

Lubricating oil in a refrigerating compressor, however, must do more than actually lubricate. It must resist reaction with the refrigerant employed and withstand chemical breakdown

as far as possible. It is for this reason that the term chemical stability has come to be recognized as descriptive of the outstanding property in a lubricating oil designed for such work. Physical characteristics can usually be met in the refinery according to any of the specifications laid down by the compressor builders. It might at first seem rather difficult for the refiner to consistently produce a light-medium viscosity oil having a pour test of say from minus 30 to minus 40 degrees Fahr. Actually, however, this is only a matter of selecting the most suitable grade of crude and extending the process of refinement in order to remove those hydrocarbon components which would tend to cause the oil to congeal. The same holds true for practically any other physical specification.

None of these procedures, however, control the chemical stability. That becomes a function of the petroleum chemist in the selection of methods of refinement which will remove those unstable hydrocarbon components which would most readily tend to enter into chemical reaction with oxygen or the refrigerant to form tarry or gummy deposits. It is the formation of such deposits which is usually the cause of difficulty in the operation of any such unit. For this reason many of the leading manufacturers of electric refrigeration and air conditioning machinery are devoting intensive research at this time to the study of the cause of such deposits. It is all very well to attribute it to what the petroleum chemist terms the presence of unsaturated hydrocarbons. The identification and segregation of these compounds, however, is a difficult matter. Normally one can only hope to succeed by a process of trial and error in the application of a wide variety of methods of test and in studying the applicability of methods of selective refining to the numerous types of crude oils available for the manufacture of lubricating oils today.

Some of the most noteworthy research in this connection has led to the development and acceptance of a number of very interesting methods of test for the determination of the chemical stability of lubricating oils intended for refrigeration compressor service. In this way prediction of their durability can be more definitely made than by visual study of physical characteristics.



Courtesy of Norge Division, Borg-Warner Corporation.

Fig. 1—Showing the Norge air-cooled type condensing unit with details of the Rollator principle. The three moving parts indicated as 1, 2 and 3 are respectively the blade, the roller and cylinder. These parts operate continually in a bath of oil.

THEORY OF REFRIGERATION

There are certain terms attendant to refrigeration and especially air conditioning which should be of interest. Many are technical. Some we used to know when we studied physics in school. All, however, may require discussion in consideration of compressor design and application of cooling equipment.

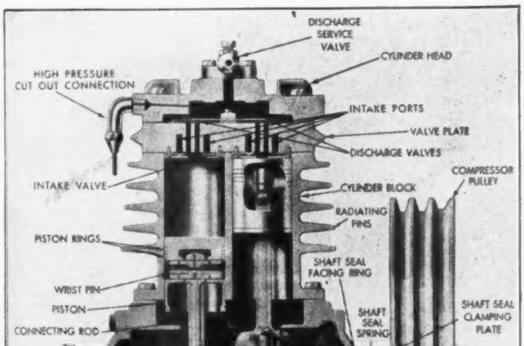
Refrigeration is understood as that process whereby heat is removed. The purpose of refrigeration is to bring about a condition of cold among materials, or within a confined space.

Heat is a form of energy. It is much the same

as mechanical or electrical energy in its activity. In any object or space where heat energy is intense or active, there is a condition of warmth which may range from the uncomfortable to the unbearable stage, according to the amount of energy involved. Where heat is absent there is a condition of cold, which by the same premise may be uncomfortable or unbearable if it is intense.

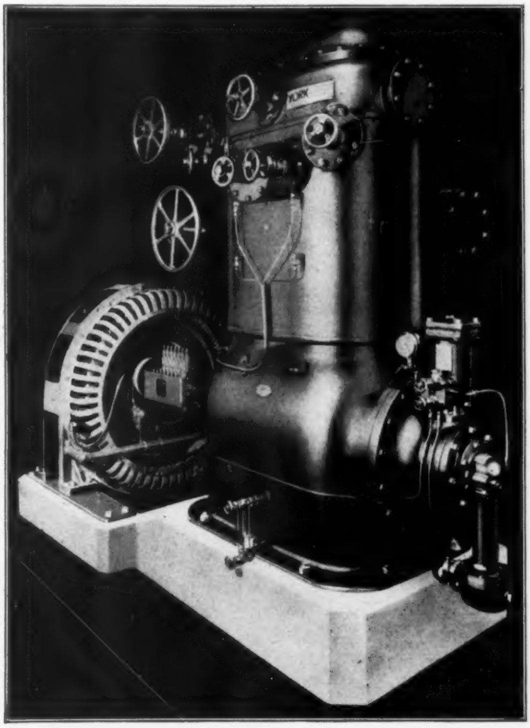
Cold is brought about, as stated above, by the removal of heat. The most familiar example of this is in the operation of the conventional ice box, whereby melting of ice absorbs heat; this latter being carried away by the ice water as the ice melts. In the average ice box of limited space and ice capacity refrigeration will normally be a variable quantity. If, of course, there is capacity for sufficient ice, and were it practicable to insulate the container to a sufficient degree and refrain from opening the doors, the ice content would last for a long time. Normally, however, it melts comparatively rapidly, and as the amount of ice available to furnish refrigeration is reduced less cooling results, with a proportionately slow rise in the temperature of the refrigerated space.

Heat can be distributed by conduction, convection or radiation. The direction of travel will always be from the warmer to the colder object. The greater the temperature difference between any two such objects the faster will be the rate of heat exchange. It is, of course, difficult to measure this rate of exchange without



Courtesy of General Electric Company.

Fig. 2—Sectional view of the General Electric CM compressor showing details of construction. Note in particular the bearing design and relative location of the lubricated elements.



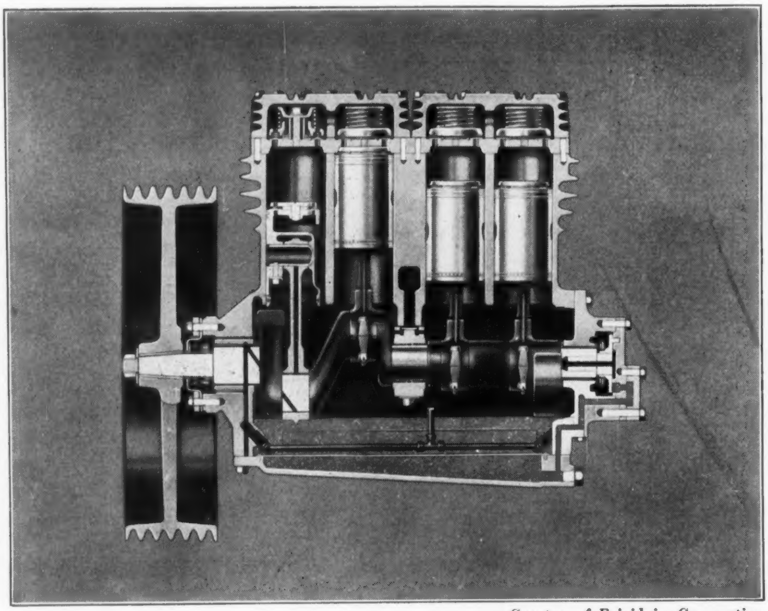
Courtesy of York Ice Machinery Corporation.

Fig. 3—A York 2-cylinder vertical single acting enclosed Freon compressor. Lubrication is automatic and of the dual type. A force feed recirculating system with geared oil pump at the end of the crank shaft provides positive lubrication of main bearings, crank pins, piston pins and other moving parts within the unit. A secondary force feed system is installed for cylinder lubrication.

laboratory apparatus. Such apparatus is also essential for measurement of the amount of heat. It is practicable, however, to determine the comparative intensity of heat at any point and at any time by a thermometer. Normally, this comparison is made with respect to the boiling or freezing point of water. It is a well known fact to all that heat as measured by the thermometer is indicated in degrees, according to the type of scale used; Fahrenheit being customary in English speaking countries, the Centigrade scale in turn being adapted to scientific work and foreign countries. In turn, the quantity of heat is normally measured in terms of British Thermal Units in the United States and other English speaking countries; 1 B.T.U. being the amount of heat necessary to raise the temperature of 1 pound of water 1 degree Fahr.

With an understanding as to the relation of heat to refrigeration, one can now more clearly visualize the principles of refrigeration as based upon a change in state of a liquid or gas. In the development of the electric refrigeration

and air conditioning industries materials other than ice have been used for the removal of heat. In contrast with ice, however, one is never



Courtesy of Frigidaire Corporation.

Fig. 4—Showing cutaway view of the Frigidaire 4-cylinder air conditioning compressor. All parts of this machine are designed with very accurate precision and lubrication is entirely automatic.

working with any of these materials in solid form, only in the liquid and gaseous state. They must, therefore, be handled within tightly enclosed systems capable of withstanding considerable pressure due to the changes which occur. These systems provide means for reclaiming the refrigerant after it has passed from the liquid to the gaseous state. They also enable control so that it can be used repeatedly without loss. Were a system of this type not used, the continued leakage of the refrigerant in its gaseous state would not only be costly, but in some instances a violation of safety and fire laws.

In view of the fact that we are dealing with both liquids and gases, there must be a high and low pressure side in every refrigerating system involving compression. Pressure is imparted to the refrigerant in the compressor, which is, therefore, partly on the high pressure side. On the low pressure side the refrigerant is relieved of this pressure and allowed to expand. In this process of expansion heat is accumulated or absorbed, and refrigeration is thereby brought about. The cycle is completed by return of the refrigerant to the compressor. Compression, whereby the gas is crowded into a much smaller space results in an increase in temperature. Cooling of this gas, therefore, involves one of the stages following compression. It is known as condensation, and may be accomplished either by water or air, according to the design of the unit. Sufficient cooling must be available to reduce the gas completely to a liquid state prior to the process of expansion. The above holds true regardless of the type of refrigerant. It has been the basis of the ice manufacturing industry by means of ammonia or carbon dioxide for years, just as it is now applicable to sulfur dioxide, methyl chloride, Freon, Carrene, and any of the other halogenated hydrocarbons now being used.

There are, therefore, three essential parts to the modern refrigerating system, i.e.,

1. The refrigerated fixture.
2. The cooling unit, and
3. The condensing unit.

The refrigerated fixture is the box, cabinet or cooler in which materials such as foodstuffs, furs, etc., are to

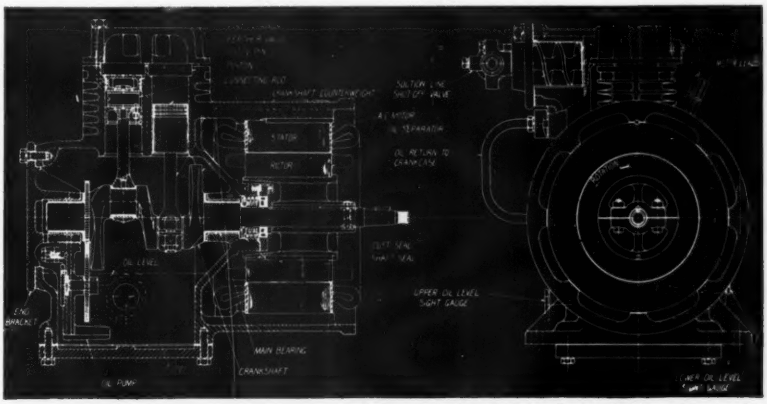
Courtesy of Carrier Engineering Corporation.

Fig. 5—Open view of a Carrier centrifugal refrigerating compressor showing the design of the interior and essential piping.

be stored and preserved. It must, therefore, be constructed in such a manner, and of such materials as to provide maximum resistance to

heat transfer from any outside source. The more effective the insulation the more constant will be the operation of the compression unit, likewise the more economical.

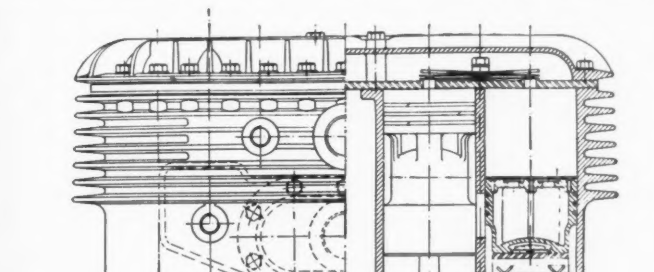
The cooling unit, in turn, is the mechanical contrivance which replaces the cake of ice in the conventional ice box. R. J. Thompson refers to it as an absorbent or sponge, so to speak, for it soaks up the heat that is contained in the interior of the cabinet or the material to be cooled. The cooling unit is normally an arrangement of coils designed to enable maximum refrigeration by rapid transfer of heat from the space within the cooler or cabinet to the refrigerant. This transfer of heat is brought about by boiling or vaporization of the latter in the coils.



Courtesy of Westinghouse Electric & Manufacturing Co.

Fig. 7—Detail view of a Westinghouse compressor designed for air conditioning service. Note oil level in the crankcase and relative location of oil pump, also means for circulation to and through the bearing clearances. Also note in particular the location of the oil separator and means of oil return to the crankcase.

The condensing unit is a heat exchanger designed for removing heat from the system which has been absorbed from the air or materials within the refrigerator by the cooling unit. The compressor serves as the medium for reclaiming the gaseous refrigerant, the condenser for restoring it to its liquid state so that it can be used over again.



Courtesy of Baker Ice Machine Company

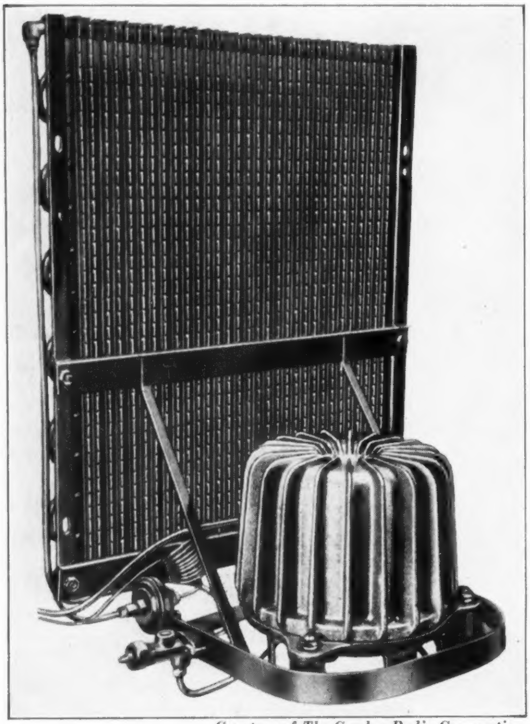
Fig. 6—Section through a Baker reciprocating compressor. Note that Timken roller bearings are used as main bearings. All the bearings in this unit are under full force feed lubrication which is maintained by a built-in, positive drive high pressure gear type oil pump.

There are three types of compressors in common use in refrigeration and air conditioning service today, notably the reciprocating, rotary and centrifugal. Normally the type which can be used is dependant upon the boiling point of the refrigerant and the pressures which the resultant gases produce at various temperatures. Under normal operating conditions, Thompson* advises that the reciprocating compressor can be successfully used with refrigerants having boiling points of less than 15 degrees Fahr., the rotary type with refrigerants of boiling points ranging from 10 to 75 degrees Fahr., and the centrifugal units with a boiling point range of from 70 degrees Fahr., and above. In addition, the type of compressor must also be studied with respect to the pressure characteristics of the particular liquid refrigerant to be used; the reciprocating type being best adapted to refrigerants which operate at positive pressures, the rotary type, in turn, being used with those which can be handled very close to atmospheric pressure, while the centrifugal machine is applicable to refrigerants which must be handled under a vacuum or under negative pressures.

There is always a certain amount of suction action at the compressor. This reduces the pressure in the cooling coil, thereby enabling the liquid refrigerant to boil more freely and furnish an abundance of gas for carrying away heat units which have entered the cooling

* R. J. Thompson, Kinetic Chemicals, Inc.

coil. Due to this reduction in pressure, the boiling or vaporization point of the refrigerant is accordingly lowered, consequently vaporiza-



Courtesy of The Crosley Radio Corporation.
Fig. 8—Showing the Crosley rotary compressor. This machine possesses all the advantages of a hermetically sealed unit; the rotor with the eccentric impeller and blade being the only moving parts. These operate constantly in a bath of lubricating oil.

tion in this coil takes place vigorously while the machine is operating.

The High and Low Pressure Sides

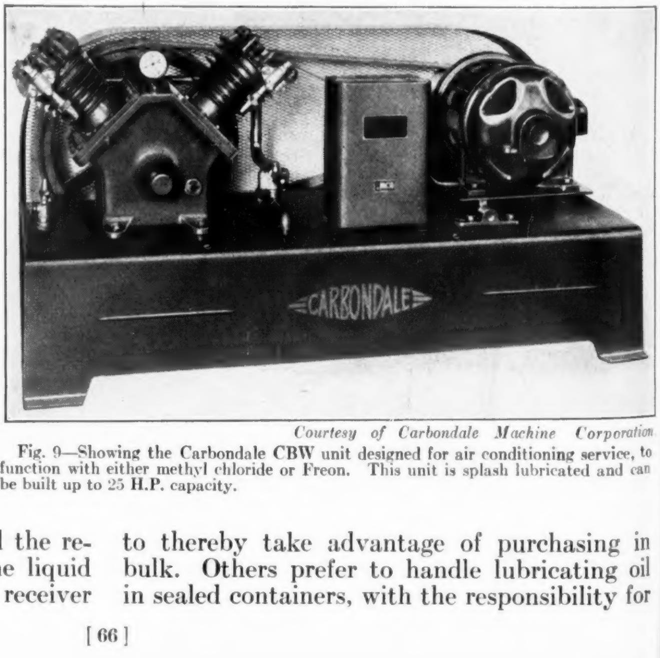
Reference has been made above to the high and low pressure sides of the refrigerating system. It is well to note the dividing points. Normally these are the discharge valve in the compressor, and the needle or expansion valve adjacent to the receiver. The refrigerant gas, after it has been compressed by the piston or rotary mechanism of the compressor, is forced through the discharge valve into the condenser. As this occurs the temperature is raised considerably above that of the surrounding media. Heat units, therefore, begin to pass from the gas to the cooling medium in the condenser, which may be either air or water. Thereby heat is extracted and the refrigerant gas is changed back into the liquid state, in which form it flows into the receiver or sump tank, and thence via a liquid line, through a needle or liquid control valve, a suitable float valve or an expansion valve.

From here on during the cycle we are dealing with the low pressure side. In other words after the liquid refrigerant has passed the liquid or expansion valve, it is admitted into the cooling coil as required, to replace the liquid refrigerant which has been evaporated. Here it can expand or vaporize in accordance with the amount of heat which is carried to it from within the refrigerator. This heat-laden gas then passes via the suction line to the compressor for recompression and recirculation.

While dealing with the compressor, it is also interesting to note that it plays another part by virtue of its being able to change the pressure on the surface of the liquid refrigerant in the cooling unit. This, of course, will have a direct bearing on the temperature. This can be governed by a suitable pressure control or thermostat. These latter elements thereby influence the operation of the compressor within certain definite predetermined points, causing it to start operation as soon as the temperature has reached the higher limit, and to stop when the temperature has been reduced to the lower limit.

LUBRICATION PROCEDURE

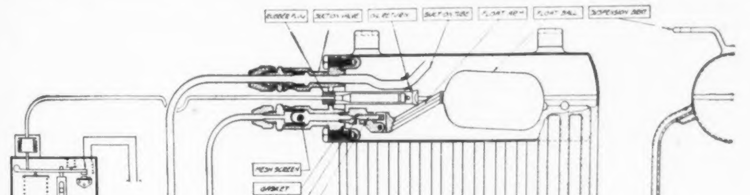
Lubrication of the condensing unit, as applied to either electric refrigeration or air conditioning, is a function of the builder at the time of manufacture. Normally, it is taken care of on the production line at the time the system is being dried. If production is extensive, some builders may dehydrate their oil simultaneously, to thereby take advantage of purchasing in bulk. Others prefer to handle lubricating oil in sealed containers, with the responsibility for



Courtesy of Carbondale Machine Corporation
Fig. 9—Showing the Carbondale CBW unit designed for air conditioning service, to function with either methyl chloride or Freon. This unit is splash lubricated and can be built up to 25 H.P. capacity.

dehydration being assumed by their oil company. This latter practice is widely customary in servicing units after they have been placed in operation. As a result, the owner or operator is normally relieved of the responsibility of lubrication. In other words, all machines as they leave the manufacturer's plant are lubricated with an adequate charge of oil which, barring unforeseen developments, should be capable of maintaining lubrication for a period of two years or longer, according to the operating conditions.

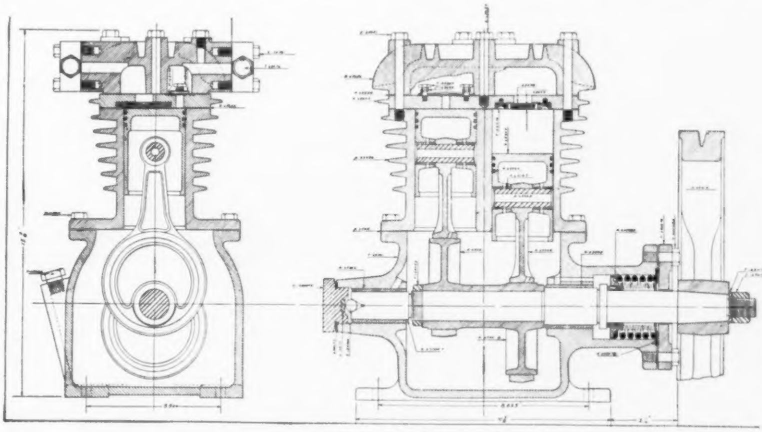
When re-lubrication is necessary this normally becomes a part of the service procedure. Uniformity in lubrication is thereby assured and the possibility of use of an unsuitable oil by any machine owner is entirely eliminated.



Courtesy of Stewart-Warner Corporation.

Fig. 10—Details of the Stewart-Warner refrigerating system. Special oil slinger paddles attached to the eccentric splash oil on to the cylinder walls and to the other working elements.

It has been essential for the builders to follow such a procedure due to the properties of the various chemicals used for refrigeration. In the presence of unsuitably refined oils which may not be of adequate chemical stability, objectionable deposits may be formed which may impair free circulation of the oil and lead to mechanical difficulties due to the extremely low clearances which are customarily used.



Courtesy of Brunner Manufacturing Company.

Fig. 11—Cross sectional view of the Brunner R-650 compressor, showing method of sealing employed.

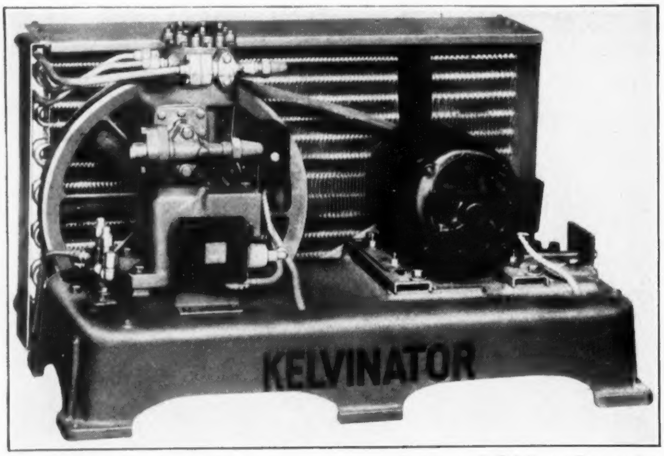
Another factor which imposes a comparatively severe requirement upon any oil used for electric refrigeration service is that in addition to lubricating the compressor mechanism, it must also serve as a cooling medium for the stator windings in some types of machines. In such units the same oil also lubricates the motor bearings.

The owner or operator should also realize that certain refrigerants are completely miscible with petroleum lubricating oils. In air conditioning service we are particularly concerned with Freon and to some extent with Carrene and methyl chloride, although there are a considerable number of other refrigerants of halogenated hydrocarbon nature, or (as the chemist terms them) the halo-fluoro derivatives of aliphatic hydrocarbons which must also be considered.

Relation of Compressor Design

The extent to which the compressor oil in a refrigerating or air conditioning system may

come into appreciable contact with the refrigerant will, of course, depend upon the type of compressor. The centrifugal machine, as designed for air conditioning service, presents a comparatively simple problem involving the lubrication of ring-oiled bearings and the maintenance of a seal against loss of vacuum. Normally a certain amount of transfer of refrigerant from the refrigerating system to the lubricating system takes place due to the absorption of refrigerant by the oil. Due to the redistillation that is provided during operation this absorption of refrigerant in the oil will not be sufficient to give any concern as to the resulting lubricating ability of an oil which has been specially refined for this class of service.

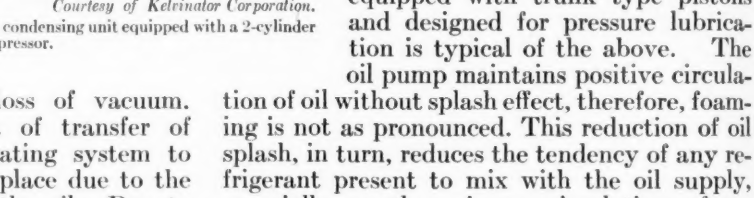


Courtesy of Kelvinator Corporation.
Fig. 12—The Kelvinator 1½ H.P. air-cooled condensing unit equipped with a 2-cylinder vertical reciprocating, single-acting type compressor.

The method of lubrication is of more importance, however, in the reciprocating machine. Small tonnage units, designed for splash lubrication, as are so many of the unit type reciprocating railway or household machines, depend upon oil thrown from the crank to splash the necessary amount of oil to the cylinders. Some of this oil is bound to pass over to the high pressure side and become mixed with the refrigerant. For this reason there is provision for return of the refrigerant vapors and oil directly to the crankcase. In such machines an oil level regulating device is, therefore, frequently installed, although if care is observed not to charge the compressor with too much oil to begin with, the oil level regulator may not be necessary; it is, therefore, not always used on the small household type of machine. Of more importance, however, is the oil separator and its relative location, especially when using a refrigerant which is miscible with oil to cause reduction in viscosity.

On the other hand, the reciprocating compressor can also be built so that the refrigerant vapors are kept entirely apart from the crankcase. In such machines the possibility of mixture with oil, at least at this point, is largely eliminated. This enables the oil to maintain its original viscosity or merely to follow the normal reduction in viscosity which would take place as the crankcase comes up to average operating temperature.

The enclosed crankcase machine equipped with trunk type pistons and designed for pressure lubrication is typical of the above. The oil pump maintains positive circulation of oil without splash effect, therefore, foaming is not as pronounced. This reduction of oil splash, in turn, reduces the tendency of any refrigerant present to mix with the oil supply, especially as there is no circulation of refrigerant vapors within the crankcase. Location of the oil pump in such a machine must, of course, be carefully studied; authorities recommend that it be at the lowest point in the case to insure against loss of suction and the resultant reduction in volume of oil circulated



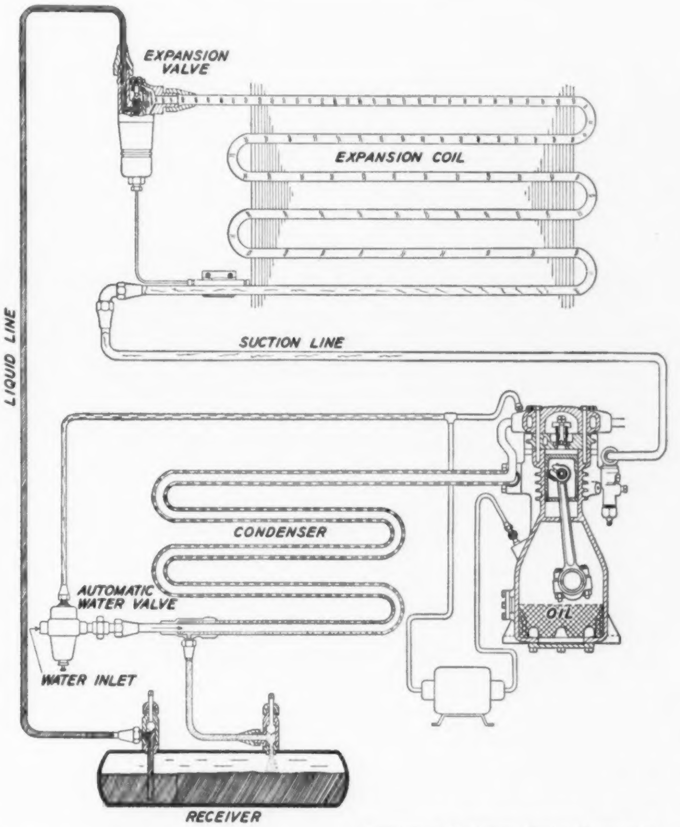
Courtesy of Williams Oil-O-Matic Heating Corporation, Ice-O-Matic Division.
Fig. 13—Oiling system of a Williams Ice-O-Matic refrigerating unit showing in particular the construction of the oil pump. This latter is connected to and rotates with the crankshaft.

which might readily lead to impaired lubrication. Obviously, the more positive the oil circulation the more constant will be the pressure on the resultant oil films.

The cross-head type of reciprocating compressor is adaptable to large tonnage, central station, air conditioning service. In this unit the refrigerant vapors are also kept out of the base or crankcase of the machine, or apart from the compressor end. Instead, they are returned directly to the cylinder block. As a result, there is no possibility of the oil in the case becoming mixed with refrigerant, so here again the possibility of foaming is reduced, along with artificial reduction in viscosity. Since lubrication of the crankcase elements or external parts is maintained entirely independent from the cylinders, it is customary to provide for injection of a certain amount of oil into the refrigerant return line to take care of piston and valve lubrication and protection of the cylinder walls against scoring. In such machines automatic circulation of lubricant to the external parts is the usual procedure, using straight mineral oil of medium viscosity. Normally, a high grade engine or machine oil will serve this purpose.

Types of Lubricating Systems

Methods of compressor lubrication have been most carefully studied in the development of the unit type air conditioning or refrigerating compressor. With automotive experience as a background, and the comparatively successful results obtainable from splash lubrication as it was used when the electric refrigeration industry first came into prominence, it was logical that this means of lubrication should first be favored. It has proved its dependability and economy, and still is preferred by many builders. More recently, however, the adaptability of pressure has been the subject of considerable research, designed to function either alone or together with splash. The objective has been to obtain positive circulation of oil throughout the compressor and to eliminate foaming as far as possible. Obviously in a splash lubricated reciprocating compressor, foaming will always be present. The extent to which it may be objectionable will depend upon the oil level, and the location of the suction valves. Inasmuch as the unit type of compressor takes its suction through the crankcase, if the foam level rises to a sufficient degree foam may be carried over with the refrigerant to cause serious retardation of heat transfer. Ultimately, if allowed to continue, cleaning of the system may be necessary. The attendant expense is, of course, objectionable.



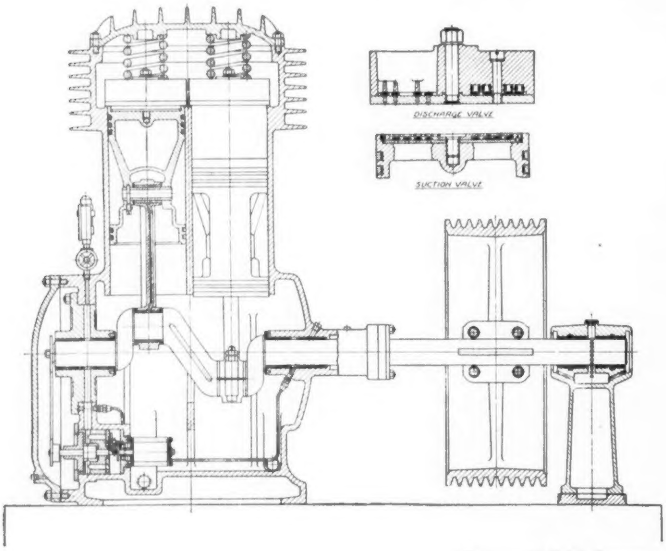
Courtesy of Universal Cooler Corporation.

Fig. 14—Diagram of the Universal Cooler refrigerating cycle with respective elements clearly indicated. In this unit all refrigerant gases and vapor are excluded from the crankcase, which holds only the lubricating oil and the oil mist from the crankcase splash.

Principle of the Gear Pump

Pressure alone, by means of the automotive type of gear pump for oil distribution, has also proved adaptable to the refrigerating compressor. The typical gear pump, as designed for positive delivery of oil, is a comparatively simple device, consisting of a pair of gears mounted in a suitable housing. The normal location of such a pump is in the base of the crankcase of the compressor, some designers preferring to place this pump at the lowest part of the case. Others are of the opinion that the pump should be set just above a depression or catch basin in the case to provide means for trapping foreign matter and preventing it being circulated through the lubricating system. Usually, however, foreign matter in a well designed system using properly refined oil will be conspicuous by its absence.

Irrespective of the location of the pump, however, suction is automatically maintained by gravity, since the pump is below the normal oil level. The discharged oil, under pressure according to the speed of rotation of the gears and their relative tooth dimensions, is led from the discharge side of the pump to the connecting rod bearings and other elements by drilled passages and suitable piping connections. As oil passes out from the bearing clearance spaces, or drips from the cylinder walls or other parts of the interior housing, it returns to the case or oil sump by gravity for recirculation.



Courtesy of Frick Company.

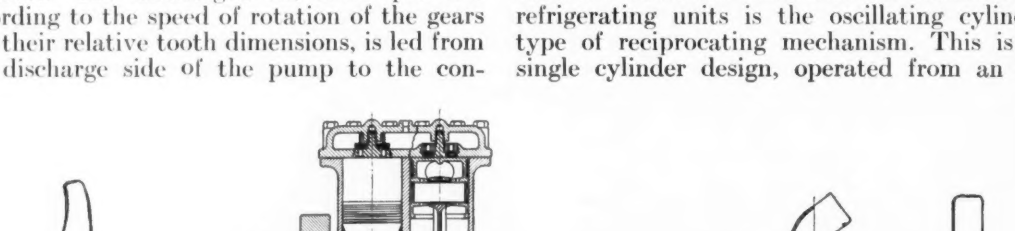
Fig. 15—Sectional view of the Frick type FR enclosed Freon compressor. A unique feature of this machine is the force feed oil pump located in the base of the crankcase and operated by a chain connection from the main shaft. Internal piping carries oil to the main bearings and other elements, the oil flowing therefrom back to the case by gravity.

Rotary Pump Operation

The principles of rotary motion are involved in the floating blade type of oil pump. Two blades, free to move in a slotted rotor, serve as the pumping media. In the General Electric design this rotor is fixed to the lower end of the vertical motor shaft. The oil is carried in the base of the unit, being drawn up and pumped through a passage drilled in the motor shaft and thence through other passages to the yoke arrangement and lower shaft bearings. The majority of the oil, however, goes to the self-aligning top bearing and to the cylinder wall. On leaving these elements, part of this oil returns to the base, the remainder flowing through the stator of the motor to cool the windings.

Oscillating Cylinder Design

Another type of oil pump which has been studied in connection with commercial refrigerating units is the oscillating cylinder type of reciprocating mechanism. This is of single cylinder design, operated from an eccentric on the end of the crankshaft. The entire assembly is located so as to be readily accessible for inspection without removal of



Courtesy of Waukesha Motor Company.

Fig. 16—Showing a Waukesha ice-engine installation in detail with oil level indicated in the crankcases of both the engine and compressor. Lubrication of this latter is maintained entirely by splash.

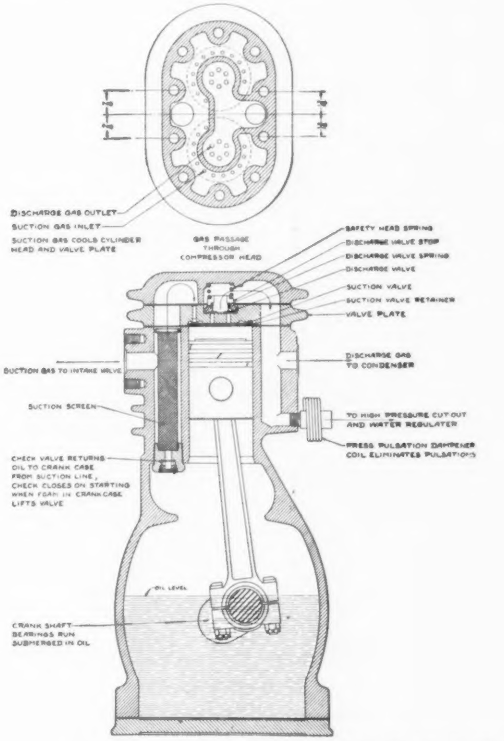
other parts. This pump is designed to supply oil under pressure directly to the two main bearings. From here oil is passed through holes in the crankshaft to the connecting rod bearings, center bearing and shaft seal. Through tubes a part of this oil is also pumped to the piston pin bearings. The cylinder walls, however, in any machine equipped with this type of pump are splash lubricated.

THE CHEMISTRY OF REFRIGERATION

Of the several chemicals used as refrigerants in air conditioning and refrigeration, sulfur dioxide, methyl chloride and Freon (dichlorodifluoromethane), or F-12, require the most careful attention from the viewpoint of their potential effect upon petroleum lubricating oils through chemical reaction.

Sulfur dioxide in the presence of but slightly more than a trace of water will react chemically to form corrosive acids. Where the lubricating oil has not been most carefully refined to render it as chemically stable as possible, there will also be a possibility of breakdown of the hydrocarbon structure of such an oil in the presence of sulfur dioxide. This will result in sludge formation and accumulation of gummy material which may seriously impair the operation of the unit and especially the distribution of the lubricant. High dielectric strength as an indication of freedom from water is, therefore, a most important property in an oil for use with sulfur dioxide.

In air conditioning work Freon and Carrene have become practically the universal refrigerants, the former being especially adaptable to the unit type machine and for railway service. Lubrication of a reciprocating or rotary type compressor operating on Freon requires a thorough understanding of the fact that this refrigerant is entirely miscible in straight mineral lubricating oils. As a result of this characteristic of Freon, there is a decided reduction in the viscosity of the ultimate mixture. Until quite recently the trend in the petroleum and refrigerating industries has been to select a lubricant of considerably higher viscosity than would normally be called for in the lubrication of compressors of the same capacity operating on some of the other accepted refrigerants. Lately, however, certain authorities among the manufacturers of air conditioning machinery in particular have become convinced that the Freon-lubricating oil vapor, as developed in the operation of an air conditioning unit, has an appreciable lubricating value. In order to prove this point and to eliminate the possibility of unnecessary increase in power consumption by use of too heavy an oil, practical study of this problem has recently been inaugurated. The data to date indicates that in average railway, commercial or household air conditioning service, it is advisable to regard approximately 500 seconds Saybolt Universal viscosity at 100 degrees Fahr. as the probable maximum viscosity. Tests on lighter oils have indicated that in all probability even this vis-



Courtesy of General Refrigeration Corporation

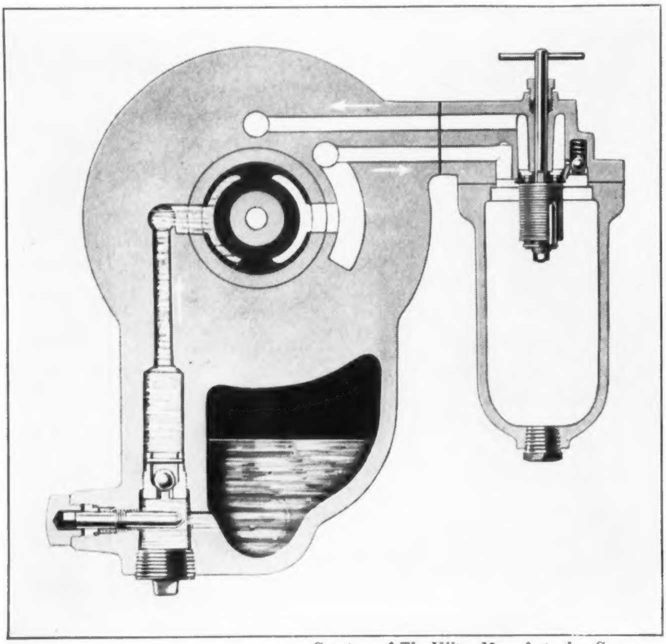
Fig. 17—Detailed view of the Lipman compressor. The high oil level carried in this unit maintains a complete and permanent oil seal over the shaft. There is also a foaming regulator installed which allows oil returning from the suction line to return to the crankcase.

cosity can be somewhat reduced, especially if the oil is highly resistant to chemical breakdown and the formation of non-lubricating deposits on the moving parts.

Lubricants for such service are consequently regarded as specialties. The need for this is enhanced by the desirability of eliminating as far as possible chemical reaction with any of the metals, alloys or fabrics used in the manufacture of the compressor or refrigerating system. In some instances reaction of this sort might be comparatively harmless. In others, permanent damage to the system may result with leakage of perhaps toxic vapors, loss of refrigerant, or at least objectionable odors from certain types of gasket materials.

This has called for the development of certain types of breakdown tests wherein these materials are exposed to lubricating oil and the refrigerant, frequently under operating pressures and temperatures, over a considerable period of time. These tests make possible

laboratory observation of the ability of the oil under test to withstand breakdown. In effect, this becomes a measure of the degree of refinement. This latter has been erroneously over-stressed in the manufacture of certain



Courtesy of The Vilter Manufacturing Company.
Fig. 18—Showing details of the oil pump as applied to the Vilter Freon compressor. This unit is of a completely hermetically internal design, the pump being of the automatic reversal gear type mounted at the end of the main bearing.

types of virtually colorless oils for refrigeration purposes. Advances made in the study of oxidation of petroleum products has indicated that over-refinement may increase the susceptibility to breakdown and markedly reduce the lubricating value.

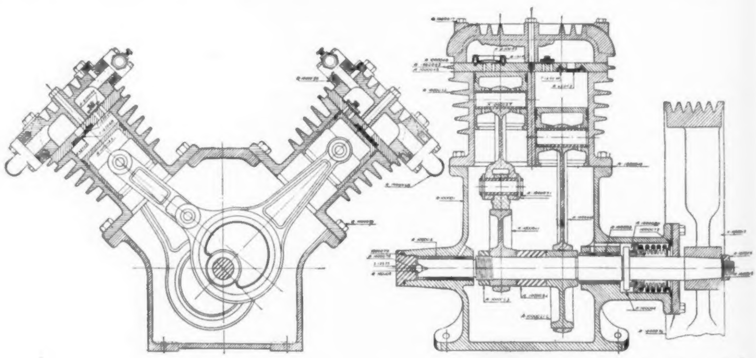
Foaming

Foaming, while not a chemical reaction, requires consideration whenever the oil is to be used in a sealed machine, and where it functions as a coolant for the motor windings as well as a lubricant for the moving parts. Usually an excess of oil is circulated in machines of this type by means of a suitable pumping device. It is this excess which serves as the cooling medium during the course of circulation through the unit. Abnormal tendency to foam with the refrigerant will reduce this cooling effect. In addition, if too much foam accumulates an excessive amount of oil may be carried over into the receiver and into the low pressure side of the system. Foaming will be most likely to occur with refrigerants which are miscible with straight mineral lubricating oils, when the former, in vaporous form, are absorbed and condensed in the oil. On the other hand, it is also apt to occur with sulfur dioxide. In each case it becomes most evident if the unit is overcharged with oil, and there is possibility of excessive splashing or too active circulation.

Corrosion and Resistance to Breakdown

The tendency which any petroleum lubricating oil will have to bring about the above reactions will be more or less a measure of the method of refinement. In the interest of reducing the corrosion tendency it is especially essential that the water content be practically nil; this is also necessary to prevent freezing at the regulating valve and possible restriction of flow of refrigerant. Water would also freeze in the cooling coils, to reduce evaporative efficiency. In the hermetically sealed machine a dehydrated oil is also advisable to prevent possible chemical dissociation of the refrigerant in event of a short circuit, which might lead to serious damage to the machine parts through acid formation.

The results which may accrue from chemical breakdown of the oil itself will be very disturbing in the average air conditioning or



Courtesy of Fairbanks, Morse & Co.
Fig. 19—Sectional view of a Fairbanks, Morse air conditioning compressor. This device is lubricated by splash. Large bearing surfaces are involved and oil is circulated by the churning action of the eccentrics.

electric refrigeration installation, regardless of the type of refrigerant used, for it will lead to gum formation and actual stopping of the unit. Resistance to breakdown can be determined by the chemist in terms of resistance to oxidation.

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